l'intérêt des commentaires qui l'accompagnent renouvellent notre connaissance d' l'oeuvre de Carnot dans ce domaine. Mineure en apparence, puisqu'elle devait être rapidement supplantée par les conceptions beaucoup plus rigoureuses de Bolzano, Gauss et Cauchy, cette oeuvre est importante du fait de sa grande diffusion (elle connut avant 1830 trois éditions françaises, 2 traductions anglaises, des traductions portugaise, allemande, italienne et russe) qui lui permit de rivaliser en popularité avec la *Théorie des fonctions analytiques* de Lagrange. Son analyse s'insère donc tout naturellement dans le cadre d'une étude d'ensemble, qui reste à poursuivre, sur les nombreuses tentatives de justification des principes du calcul infinitésimal entreprises depuis d'Alembert jusqu'à la grande révolution amorcée par Bolzano et Cauchy.

Que conclure quant à l'importance de l'oeuvre scientifique de Lazare Carnot? Il est certain que son renom fut assez tardif. Son *Essai* de 1783 n'eut en effet qu'un faible retentissement et son élection comme membre de l'Institut en août 1796 paraît due beaucoup plus à son prestige politique qu'à son renom scientifique. Cependant, la publication de ses *Réflexions* et de ses ouvrages de géométrie et d'algèbre, la réédition de son essai de mécanique et sa grande activité comme membre de l'Institut lui valurent la réputation justifiée d'un esprit original et solide, d'un technicien soucieux de rendre la science mieux adaptée aux applications. Par la richesse de sa documentation et l'intérêt de ses interprétations, l'ouvrage de Ch. Gillispie et de A.P. Youschkevitch donne une image nouvelle de l'oeuvre de ce pionnier de la mécanique appliquée et permet d'en mieux saisir les motivations et les répercussions.

AFRICA COUNTS. By Claudia Zaslavsky. Boston (Prindle, Weber and Schmidt). 1973. 338 p. U.S. $12.50.

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To the conscientious reviewer this beautiful book presents a problem, in that it covers so many aspects of African cultures. Yet this is most fortunate, since it is the first book of its kind; and the author wisely recognizes that to give a bare account of African numeration systems without some explanation of the social and cultural conditions that spawned them would be to give only half the picture.

The lack of a book of this kind has been notorious. Why has it been so long before someone filled this gap in the history of numeration systems? To argue that African systems were not

in the direct line of our own mathematical development would be hardly valid. Early Chinese and Japanese mathematics have been studied despite the fact that they contributed little, if anything, to modern mathematics. Also, that Egypt was a part of Africa seems to have been ignored; European historians have adopted it since it formed a part of their own cultural background, having influenced Greek culture during the period when all the countries of the Eastern Mediterranean participated in laying the foundations of our own cultures. True, Egyptian influence on Greek thought, and the discovery of the Rhind and Moscow papyri, made it natural to include Egyptian mathematics in the history of mathematics. But, as Mrs. Zaslavsky points out, Egypt was itself influenced by her African neighbors in ways not yet fully known. Furthermore, the narrowness of vision of the orthodox history is exemplified by its ignoring the fact that Arabic culture spread not only to Europe, but south to African areas such as that centered at Timbuktu.

In good part, the reason for the neglect of African cultures was undoubtedly the result of the reputation -- not earned, but imposed -- of the African cultures (excepting Egypt) as "savage," and not being worth the time to study them. As an example, the author cites L.L. Conant's attitude toward Africans as "primitive savages" (*The Number Concept*, New York, 1896). In particular, she states, "Conant sees the occurrence of numbers up to a million among South African tribes as 'remarkable exceptions' to the 'law' that 'the growth of the number sense keeps pace with the growth of the intelligence in other respects.'" One can perhaps excuse Conant to some extent since he wrote this nearly 80 years ago. But unfortunately one finds the same attitude persisting today. When will we learn that "intelligence" is virtually a constant among various "races," and that it is the cultural conditions that account for the variations in degrees of civilization?

So far as the study of African numeral systems is concerned, no progress seems to have been made from the time of Conant to that of Menninger, whose book *Number Words and Number Symbols* (published in English translation in 1969 from the revised German edition of 1958), although otherwise authoritative and remarkable for its completeness of outlook, gives very little on African numeration. Anthropologists have noted particular cases that happened to fall within special areas they were studying; but even they, until recently, were misled by their preconceptions of "primitive minds" and "pre-logical" behaviour. Actually, as the author points out (p. 15), most people in modern cultures have as much difficulty handling numbers in the abstract as any "African primitive"; the average American, for instance, learns enough about numbers and arithmetic to meet the demands of his trade or profession, and little else.

The evidence for prehistoric counting in Africa is mentioned by the author in a chapter (Chapter 2) on historical background. Particularly interesting is a tally stick found near Lake Edward and dating from the period between 9000 B.C. and 6500 B.C. It has been variously interpreted as numerical, showing a number system based on ten and a knowledge of prime numbers, or as a recording of astronomical lunar periods. In the same chapter the author gives a revealing account of early African cultures, prior to the times when Arabian and European slave trading and plundering of African resources resulted in the ruin and degradation of formerly well organized and peaceful societies. Many African number systems show the effects of acculturation, making it difficult to separate out the original from the acquired. Especially interesting is the influence of the use of cowrie shells as currency. When foreign traders discovered this custom, they brought in shells by the shipload, eventually leading to inflation and to the necessity for dealing with larger numerals.

The majority of African numeration systems are quinary but, as the author states (p. 36): "Nowhere do we find gradations based solely on five and powers of five." Usually ten or twenty form secondary bases, introduced when commercial or other needs forced the development of higher numerals. Secondary bases could be introduced without trouble, since, instead of written symbols, the African systems usually consisted of number words and "a set of standardized gestures." (*Base* is used by the author "to indicate the number or numbers which dominate the construction of the number words.")

Of special interest are the chapters (10 and 11) on games and their educational uses. Similar to the physical objects used by some of our elementary schools for the teaching of arithmetic, they apparently contributed to the instruction of the young in counting, long before our schools were established. However, games were not limited to the numberical. For instance, the author cites the case of the Shongo (Congo area) children who played with elaborate networks ("graphs"); the idea of the games being to trace the networks in the sand without tracing over any segment twice -- in other words, Euler's "Königsberg Bridge" type of problem (the solution given by the author is the one originally found by Euler).

A most important type of game, possibly of Sumerian origin and having many variations, is a "pit and pebbles" game called Bao" in the Swahili language. It requires a board with recessed cups for holding seeds or pebbles, and apparently has many educational values. Not only does it require counting, but operations such as subtraction. It has been used by social scientists, who have traced the histories of African peoples by the styles of game they play. In some cases, the origins of black people living in the New World have been traced this way.

Versions of the game have also been issued commercially in the United States.

Later chapters are devoted to geometric forms and patterns in sculpture, basketry, etc., in a way reminiscent of similar studies of American Indian art. This is an aspect of African culture which has been recognized for some time in Western cultures, as any habitué of museums of art and natural history knows.

Time-reckoning, number superstitions and the effects of commerce on counting modes are all treated by the author. For example, the fear of counting humans (and animals) is widespread in Africa, and posed many problems for the tax-gatherers when Europeans laid hold of African territory. Ingenious devices were invented to circumvent the superstition.

Although the spread of Greek and Arabic learning reached such ancient cities as Timbuktu, where many scholars congregated, there were several reasons for its failing to spread in such a manner as it did in Western Europe. The African cultures were generally isolated, and even near centers of advanced learning the common people usually stuck by their traditions. And the advent of slave trading in the fifteenth century, with the consequent disruption of tribal customs and demeaning of the black, destroyed all hope of technological advance. This is briefly but adequately discussed by the author in her last chapter on "Pure mathematics in Africa." Even the introduction of schools by Europeans and Americans was usually futile because of the failure to adapt teaching methods to the prevailing cultural ways of thought. In recent years, however, changes are occurring and universities have been established. One can safely predict that, barring catastrophe, it will not be long before African mathematics and other sciences will contribute to the world development of these areas of learning.

In an extensive appendix, the author has compiled much reference material, including a complete bibliography and unusually thorough index.

This is an eye-opening book, well illustrated and unusually free of errors, and it can be read with profit by the layman as well as by undergraduates, social scientists and professional mathematicians. Hopefully, it will clear up many misconceptions about Africa and Africans. The reviewer recommends it without reserve.